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## Mating and nesting behavior of hawksbill turtle (*Eretmochelys imbricata*) in captivity

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### ABSTRACT

We previously reported that two long-term reared mature females laid a total number of 894 eggs during a total of 7 nesting times. However, we did not elaborate the relationship between mating and nesting behavior. In the present study, we investigated the relationship between mating and nesting behavior in captivity. Details of the mating and nesting behavior were monitored since December 2005 by using four highly sensitive cameras continuously throughout day and night. Two cameras were fixed on the edge of the tank observation window and two cameras on the upper side tank wall connected to an artificial sand nesting bed. Rearing methods and the feeding protocol were same as the previous report (Shimizu *et al.*, 2006). One mature male and three mature females were used for the present study. These turtles were the same turtles used for the previous study (Shimizu *et al.*, 2006). After the nesting periods in 2004, the females did not mate with the male and did not lay eggs in 2005. One time mating was first observed after the start of camera observations in December 2005 in the two females during April to May. Shelled eggs were first observed between 13 and 18 days after mating. Thereafter the first laying was observed between 24 and 33 days after mating.

**Keywords:** hawksbill turtle, *Eretmochelys imbricata*, mating behavior, nesting behavior

### INTRODUCTION

Recently, the hawksbill turtle stock has been greatly reduced by impacts related to human activity. In 1986, hawksbill turtle were listed as endangered on the IUCN Red List. To conserve hawksbill turtle, the international trade of hawksbill turtles has been prohibited by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1992. For this reason, the bekkō industry, a traditional craft of Japan, is facing a crisis. The recovery of the stock of hawksbill turtle is essential not only for the conservation but also for head starting.

We have studied propagation technologies of hawksbill turtle since 1999. In 2004, two long-term reared mature females laid a total number of 894 eggs nesting a total of 7 times during the nesting periods. So we succeeded with the spontaneous nesting of hawksbill turtle in captivity (Shimizu *et al.*, 2006). However, we did not clarify the relationship between the mating and the nesting behavior. Although the relationship between mating and nesting behavior under captive conditions has been elucidated for the green sea turtle *Chelonia mydas* (Ulrich and Parkes, 1978; Wood and Wood, 1980), there have been no studies pertaining to hawksbill turtles in captivity. To develop propagation technologies, it is important to determine the relationship between mating and nesting behavior. The relationship between mating and nesting

behavior in captivity were investigated under rearing conditions. In this paper, we report the results of the relationship between mating and nesting behavior in 2006.

### MATERIALS AND METHODS

The rearing methods and feeding protocol are the same as detailed in the previous report (Shimizu *et al.*, 2006). Briefly, the rearing conditions and experimental methods were as described below.

#### *Turtle identification used for the study*

One mature male and three mature females identified as A, B, and C were used for the present study. Females A and B laid eggs in 2004. Initial straight carapace length (SCL) and body weight (BW) of the male and females were as follows; the male was 82.7 cm in SCL and 74.8 kg in BW, female A was 77.6 cm in SCL and 71.9 kg in BW, female B was 82.7 cm in SCL and 71.8 kg in BW, female C was 69.6 cm in SCL and 49.8 kg in BW (Table. 1).

Table.1. Initial size of the hawksbill turtle used for the present study

	straight carapace length (cm)	body weight (kg)
<b>Male</b>	<b>82.7</b>	<b>74.8</b>
<b>Female A</b>	<b>77.6</b>	<b>71.9</b>
<b>Female B</b>	<b>82.7</b>	<b>71.8</b>
<b>Female C</b>	<b>69.6</b>	<b>49.8</b>

#### Rearing conditions

In the present study, a 250 kL rearing tank with a recirculation system was used. The rearing tank was connected to an artificial sand nesting bed of 13 m in length, 4.7 m in width, with a depth of sand layer of 1 m. The water temperature in the rearing tank was kept at ambient level except for between December in 2004 and March in 2005 during which it was kept at 26 °C. The turtles were fed with Japanese Anchovy (*Engraulis japonicus*) and Argentine shortfin squid (*Illex argentinus*) 3 - 5 times per week. The daily feeding rate was 1 - 2 % of the body weight.

#### Monitoring of mating and nesting behavior

In order to monitor the mating and nesting behavior, we used four highly sensitive cameras. Two cameras were fixed to the edge of the tank observation window to monitor the mating behavior in the rearing tank (Fig. 1-2). The other two cameras were to monitor the nesting behavior, and were fixed on the upper side tank wall connected to the nesting bed (Fig. 3). One camera was to identify turtle ascending to the nesting bed (Fig. 4), and the other was to determine where the turtle laid eggs in the nesting bed (Fig. 5). All data from the cameras was recorded by a hard disc recorder over 24 hour periods, and we analyzed it on the following day.

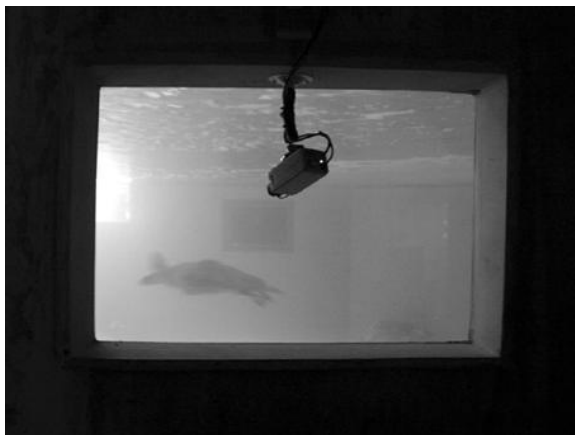


Fig.1. Monitoring camera which was fixed to the edge of the tank observation window



Fig.2. Monitoring graphics of the rearing tank



Fig.3. Monitoring cameras which were fixed on the upper side tank wall connected to the nesting bed



Fig.4. A female turtle ascending to the nesting bed



Fig.5. A female turtle searching for a good place for nesting

## RESULTS

Females A and B laid eggs in 2006, but female C did not lay eggs during the experimental periods. So, we have reported the results of mating and nesting behavior for females A and B in 2006.

### *Monitoring of mating and nesting behavior*

Mounting behavior by the male on female was observed from March in 2006. First mating of females A and B with the male was observed on 10<sup>th</sup> May and on 24<sup>th</sup> April, respectively. Mating behavior of both females was observed only one time during the nesting periods in 2006. The duration of mating of female A was 66 minutes, and that of female B was 119 minutes. The first laying of eggs by female A occurred on 3<sup>rd</sup> June, 24 days after the mating, and female B first laid eggs on 24<sup>th</sup> April, 33 days after the mating. After that, females A and B each laid eggs on 3 occasions, the former and the latter laid a total number of 461 eggs and 449 eggs, respectively. However, dropped eggs in the rearing tank were observed for female A and B, 3 times and 1 time, respectively. In this paper, we tentatively defined this abnormal laying as dropping. We could not clarify why such a dropping in the tank occurred. The laying interval of females of A and B ranged from 14 to 15 days and 18 to 19 days except for the dropping (Table. 2).

Table.2. The relationship between mating and nesting behavior in 2006

Female	Date	Behavior	No. of eggs (ind./clutch)	No. of hatchling
A	10 May	Mating	-	-
	3 June	1st Laying	137	18
	18 June	2nd Laying	168	15
	9 July	Dropping	Unknown	0
	23 July	3rd Laying	156	38
	13 August	Dropping	Unknown	0
	20 October	Dropping	Unknown	0
Subtotal			461	71
B	24 April	Mating	-	-
	27 May	1st Laying	114	0
	15 June	2nd Laying	162	48
	3 July	3rd Laying	173	78
	22 September	Dropping	Unknown	0
Subtotal			449	126
Total			910	197

## DISCUSSION

Shimizu *et al.*, 2006 reported that the two long-term reared mature females laid a total number of 894 eggs in a total of 7 times during the nesting periods in 2004. However, their study did not reveal the relationship between mating and nesting behavior. In this study, one time mating was observed in the two females during April to May. After that, shelled eggs were first observed between 13 and 18 days after mating. Thereafter the first laying was observed between 24 and 33 days after mating. As mentioned above, we first succeeded to specify the relationship between mating and nesting behavior in captivity. The first laying for green sea turtle (*Chelonia mydas*) was reported at 21–95 days after the mating (Ulrich and Parkes, 1978). The difference of duration between mating and first laying might be a species specific difference.

## ACKNOWLEDGMENTS

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